Mathematical Girls - Fermat's Last Theorem

C04

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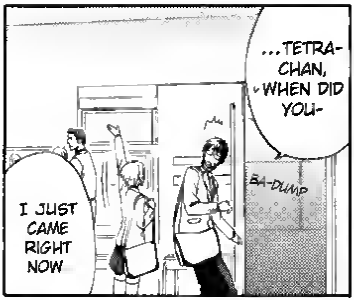
EH,
YOU WON'T BE GOING TO THE LIBRARY TODAY, MIRUKA-SAN?
NO.
AY-AY ASKED ME TODAY TO HELP WITH THE ACTIVITIES OF THE...
DI-NG
DO-NG
DA-NG
DO-NG
PIANO CLUB
MIRUKA-TAN, GOTCHA!!

第4話
Chapter 4

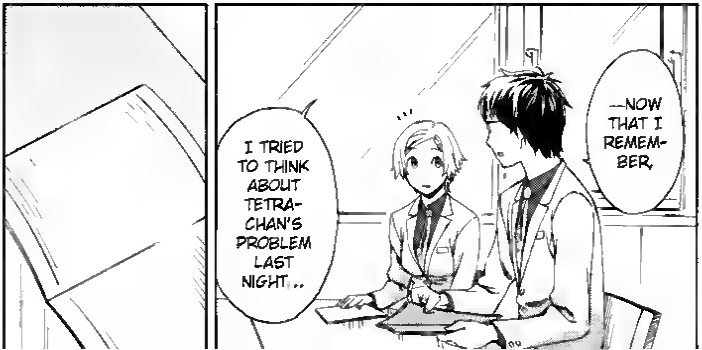
This girl is Ay-ay.
She's a second year high school student like Mirika-san or me but she's in a different class.
DRAG
DRAG
WELL THEN I'LL BE BORROWIN' HER.
CLOSE TO BEIN' ON PAR WITH ME, THE LEADER OF FORTISSIS-SIMO ♪
'COS MIRIKA-TAN'S FINGER MOVEMENTS ARE GREAT.
.....

NOTE: FORTISSISSIMO IS THE NAME OF THE PIANO CLUB.

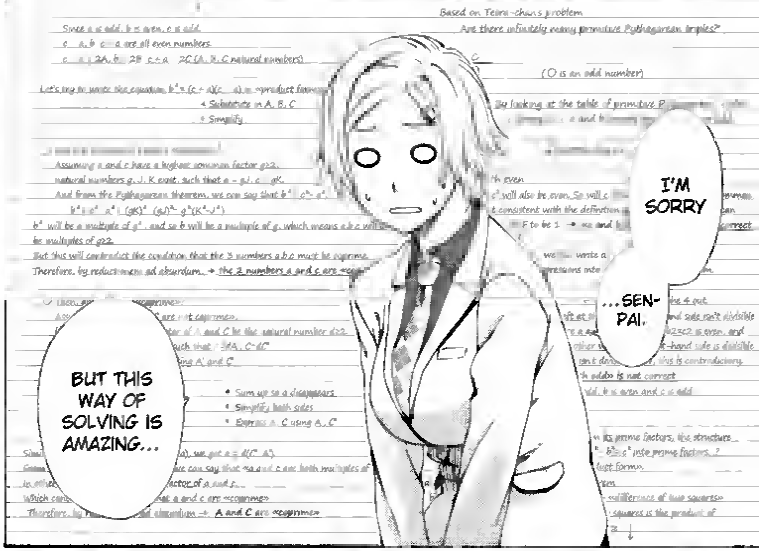

...TETRA-CHAN, WHEN DID YOU-
BA-DUMP
I JUST CAME RIGHT NOW

I HAVE WITNESSED THE SCENE OF AN ABDUCTION.

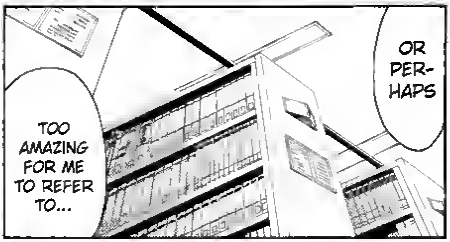
WELL THEN, SHALL WE GO TO THE LIBRARY?
TAP
AH, YEAH.


I TRIED TO THINK ABOUT TETRA-CHAN'S PROBLEM LAST NIGHT...
—NOW THAT I REMEM-BER,

S-
LIBRARY
SOME THING LIKE THAT!
I WOULD HAVE NEVER THOUGHT OF IT!!
STARE
STARE
STARE
STARE
SHH HHH —
SHE REALLY SAID IT AFTER ALL..
GLARE
SHUDDER


I'M SORRY
...SEN-PAI.
BUT THIS WAY OF SOLVING IS AMAZING...

NO, NO.
IT'S NOT LIKE IDEAS COME QUICKLY TO MY MIND EITHER.


OR PER-HAPS
TOO AMAZING FOR ME TO REFER TO...

SULK
IF IT WAS ME,
AN IDEA LIKE THAT WOULD NEVER COME TO MY MIND SO QUICKLY...

SQUAWK
SQUAWK
WHEN THINKING OF A PROBLEM IT'S
EXACTLY LIKE WANDERING AROUND IN THE MIDDLE OF A FOREST.
POKE
OUT
WELL THEN,
LET'S TRY TO THINK TOGETHER ABOUT THE TRUE NATURE OF TODAY'S PROBLEM
ALL RIGHT ...
"TO BE AN INTEGER"
THIS CONDITION IS REALLY POWERFUL.

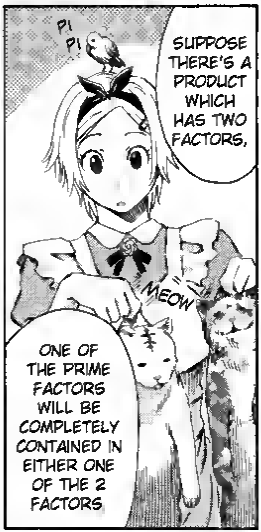
FLAP
THE SPECIAL CHARACTERISTIC OF THE PRIMITIVE PYTHAGOREAN TRIPLES
IS THAT THE NUMBERS ARE DRAWN FROM THE INTEGERS AND NOT THE REAL NUMBERS.
STEP
STEP
STEP
HUP
THE VALUES OF INTEGERS ARE DISCRETE
JUMP
THESE VALUES OCCUR AT INTERVALS
BUT INTEGERS ARE DIFFERENT.
STEP
IF THEY WERE REAL NUMBERS, THE VALUES WOULD GO ON SMOOTHLY AND CONTINUOUSLY
SHUDDER
EVEN
ODD
"CHECKING PARITY" IS AN EFFECTIVE POLICY WHEN THINKING ABOUT INTEGERS.
REAL NUMBERS DON'T HAVE PARITY.
INTEGERS DO HAVE PARITY.

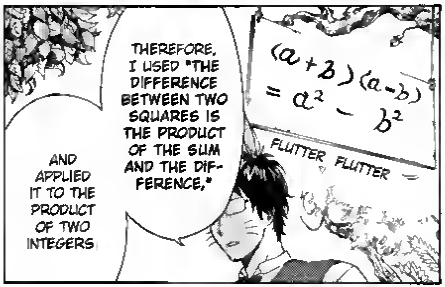
OR EVEN NUMBER X INTEGER = EVEN NUMBER.
Odd number + odd number = even number
Even number x integer = even number
AND THERE ARE USEFUL EQUATIONS LIKE ODD NUMBER + ODD NUMBER = EVEN NUMBER
WHEN WE HAVE AN EQUATION SUCH THAT: INTEGER = INTEGER,
THE PARITY IS THE SAME FOR BOTH SIDES.
BY DECOMPOSING AN INTEGER INTO ITS PRIME FACTORS, ITS STRUCTURE IS EXPOSED
ONE MORE USEFUL THING IS THAT "FROM ITS PRIME FACTORS, THE STRUCTURE OF AN INTEGER IS KNOWN."
THAT'S WHAT WE'RE GOING TO USE.
THEN "THE DECOMPOSITION INTO PRIME FACTORS OF THE LEFT HAND SIDE WILL COMPLETELY COINCIDE WITH THE DECOMPOSITION INTO PRIME FACTORS OF THE RIGHT HAND SIDE."
AND SINCE THE DECOMPOSITION INTO PRIME FACTORS IS UNIQUE, SUPPOSE WE HAVE AN EQUATION: INTEGER = INTEGER.

HOW DO WE USE THAT?
UM ...
WE APPLY "PRODUCT FORM".
A NUMBER MAKING UP PART OF A PRODUCT IS CALLED A FACTOR
FOR EXAMPLE, WHEN WE WERE TALKING EARLIER,
WE HAD A PRODUCT CALLED AC.
IN THIS CASE A AND C ARE FACTORS
I WONDER IF YOU UNDERSTAND THAT
A SINGLE PRIME NUMBER CAN'T BE DIVIDED INTO TWO FACTORS.

CORRECT.
BECAUSE A PRIME NUMBER CAN'T BE DECOMPOSED INTO ANY MORE PRIME FACTORS ..
IS THAT WHY?

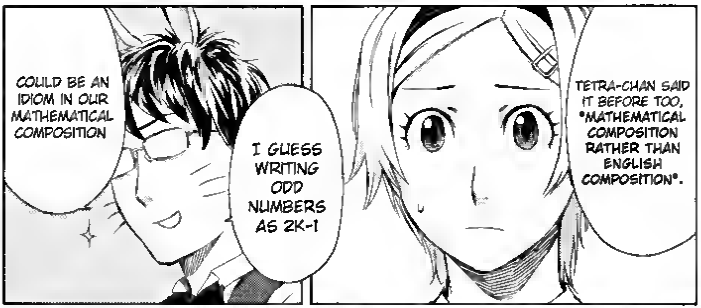
FLAP
FWSSH
SWISH
MYAAAW
AND IT'S IMPOSSIBLE FOR ONE PRIME FACTOR TO BE DECOMPOSED INTO TWO FACTORS

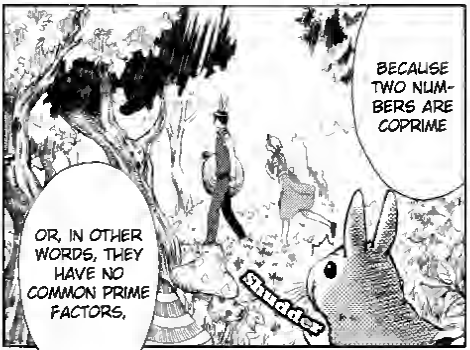

PI PI
SUPPOSE THERE'S A PRODUCT WHICH HAS TWO FACTORS,
MEOW
ONE OF THE PRIME FACTORS WILL BE COMPLETELY CONTAINED IN EITHER ONE OF THE 2 FACTORS


$(a+b)(a-b) = a^2 - b^2$
FLUTTER FLUTTER
THEREFORE, I USED "THE DIFFERENCE BETWEEN TWO SQUARES IS THE PRODUCT OF THE SUM AND THE DIFFERENCE,"
AND APPLIED IT TO THE PRODUCT OF TWO INTEGERS

THE SKILL TO "EXPRESS WORDS AS MATHEMATICAL FORMULAS" BECOMES NECESSARY.
Strike
SWISH
HISS
AND OF COURSE, WHEN WE ARE PRACTICALLY INVESTIGATING A PROBLEM,

Even number → 2k
Odd number → 2k-1
Square number → k²
IT'S IMPORTANT TO PRACTICE EXPRESSING WORDS AS MATHEMATICAL FORMULAS LIKE THIS.
FOR EXAMPLE
"EVEN NUMBERS" ARE WRITTEN AS 2K.
"ODD NUMBERS" ARE WRITTEN AS 2K-1.
"SQUARE NUMBERS" ARE WRITTEN AS K².

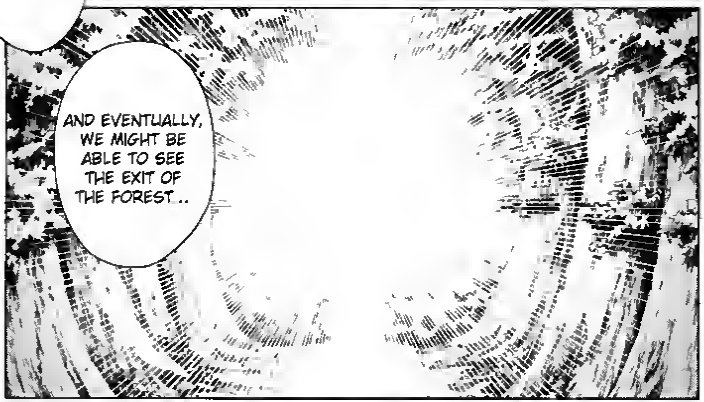

COULD BE AN IDIOM IN OUR MATHEMATICAL COMPOSITION
I GUESS WRITING ODD NUMBERS AS 2K-1
TETRA-CHAN SAID IT BEFORE TOO, "MATHEMATICAL COMPOSITION RATHER THAN ENGLISH COMPOSITION".

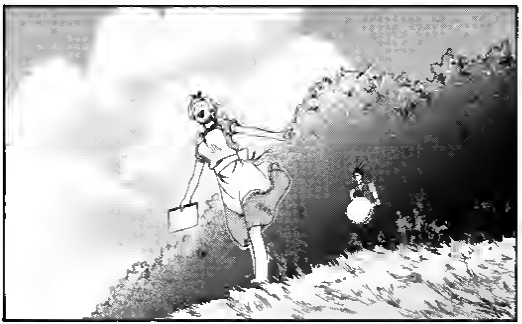

BECAUSE TWO NUMBERS ARE COPRIME
OR, IN OTHER WORDS, THEY HAVE NO COMMON PRIME FACTORS,
Shudder

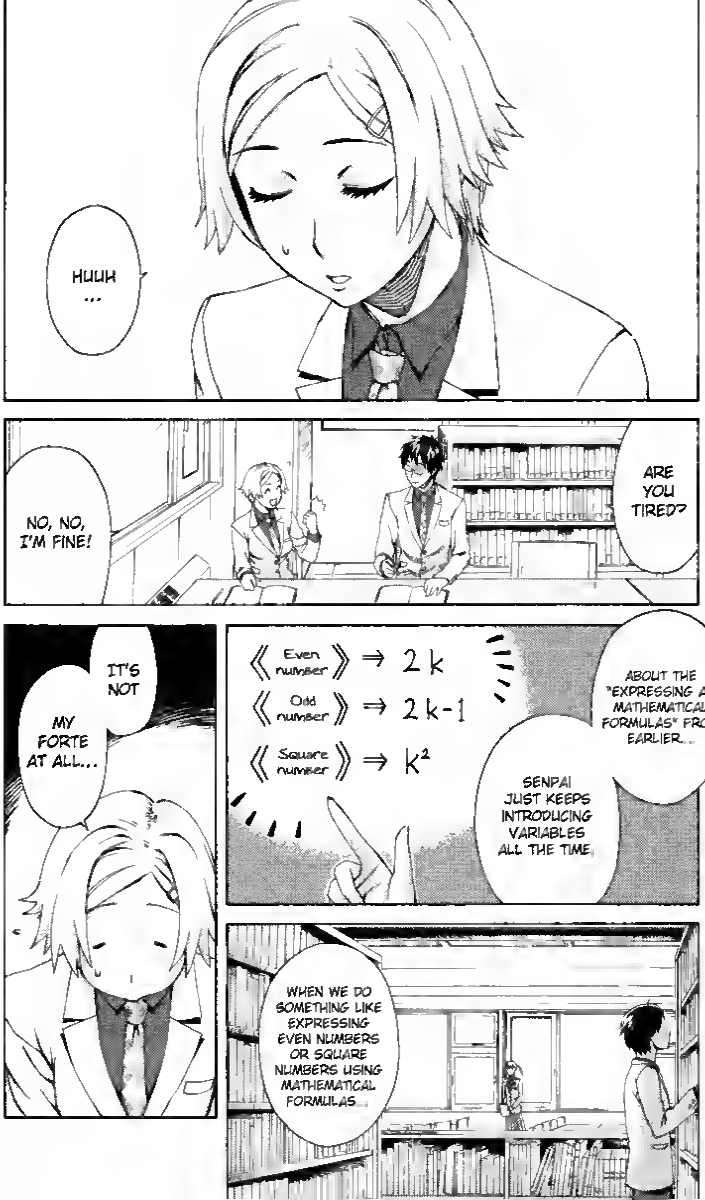
"COPRIMALITY" IS ALSO IMPORTANT.

FIND OUR LANDMARK RIBBON,
BY DOING SO, WE CONTINUE CLEARING OUR PATH AS WE GO,

WE MANAGED TO EARN AN IMPORTANT TRUMP CARD, WHICH IS "THE COPIES OF EACH PRIME FACTOR CANNOT BE SPLIT UP."


AND EVENTUALLY, WE MIGHT BE ABLE TO SEE THE EXIT OF THE FOREST ..

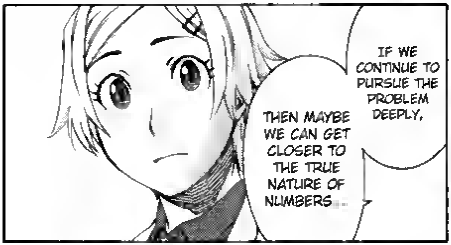


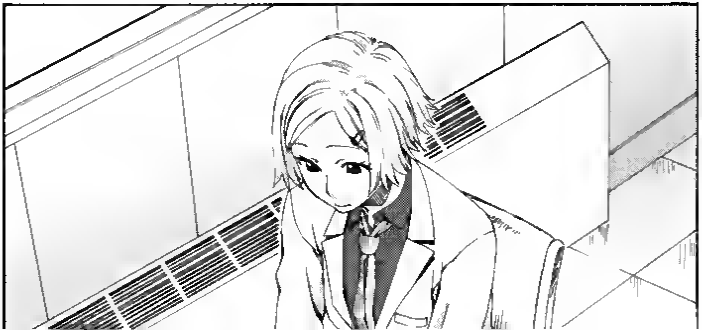

HUUH ...
ARE YOU TIRED?
NO, NO, I'M FINE!
ABOUT THE "EXPRESSING AS MATHEMATICAL FORMULAS" FROM EARLIER...
SENPAI JUST KEEPS INTRODUCING VARIABLES ALL THE TIME.
《 Even number 》⇒ 2k
《 Odd number 》⇒ 2k-1
《 Square number 》⇒ k^2
IT'S NOT MY FORTE AT ALL...
WHEN WE DO SOMETHING LIKE EXPRESSING EVEN NUMBERS OR SQUARE NUMBERS USING MATHEMATICAL FORMULAS...

IT SEEMS THAT INTRODUCING VARIABLES ONLY MAKES IT MORE DIFFICULT...
I SEE.
THE TECHNIQUE WE USE WHEN WE HAVE INTEGERS IS
CHECK PARITY, DO PRIME FACTOR DECOMPOSITION,
MAKE INTO THE FORM OF A PRODUCT, MAKE COPRIME BY DIVIDING BY THE HIGHEST COMMON MULTIPLE.
BUT IT'S NOT LIKE THINGS WILL ALWAYS WORK OUT WELL IF WE DO THAT.
YES.
WHAAAH
CAW
CAW
THIS IS JUST A HINT ABOUT THE ROUTE TO TAKE WHEN THINKING.
BECAUSE THERE ARE ALSO TIMES WHEN YOU GO THE WRONG WAY.

—THIS PROBLEM THAT MURAKI-SENSEI GAVE US,
IF WE THINK CAREFULLY, IT SEEMS THAT WE CAN GLIMPSE "THE TRUE FORM OF INTEGERS".

HOW-EVER,
!! HERE, THIS WAY !!
AH
"IF YOU'VE GONE THE WRONG WAY, YOU JUST HAVE TO TURN BACK."

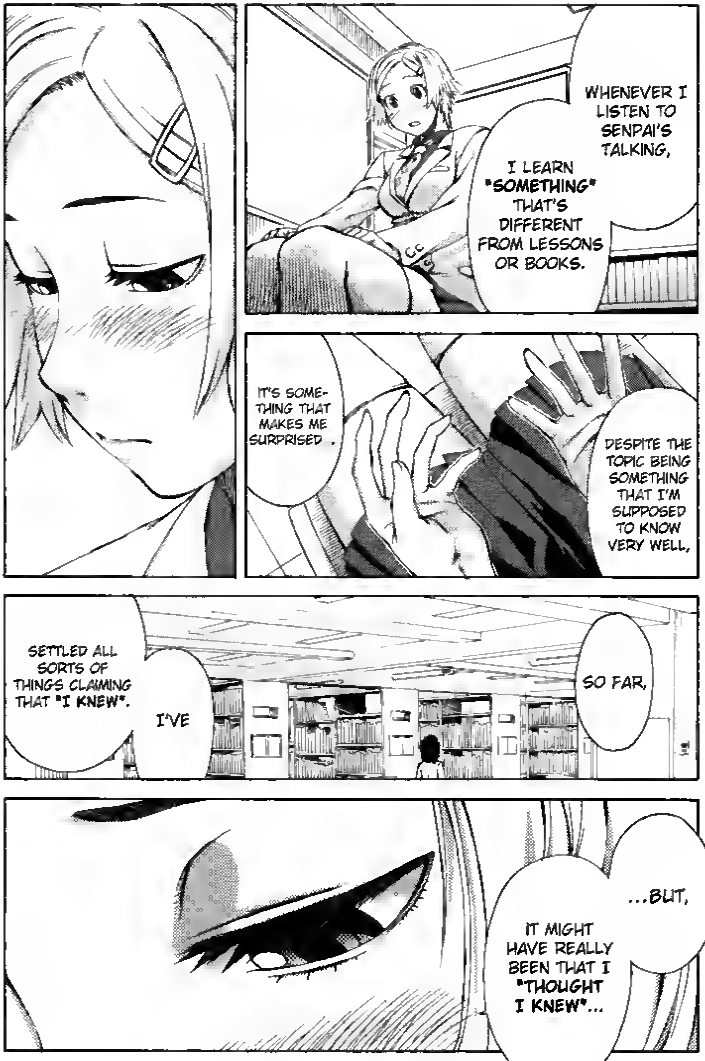

IF WE CONTINUE TO PURSUE THE PROBLEM DEEPLY,
THEN MAYBE WE CAN GET CLOSER TO THE TRUE NATURE OF NUMBERS...



SENPAI—
NO...
EH?
DO
YOU KNOW
WHAT I'M THINKING OF RIGHT NOW?
IT MIGHT BE EMBARRASSING TO DELIBERATELY SAY THIS BUT...
WELL... YOU SEE,

I WANT TO SAY.
THANK YOU VERY MUCH
—TO SENPAI.
THE QUESTION, "ARE THERE INFINITELY MANY PRIMITIVE PYTHAGOREAN TRIPLES?"
I THOUGHT ABOUT IT SO EARNESTLY...
AND THAT IS THE UNIQUE ATMOSPHERE THAT SURROUNDS PROBLEMS ABOUT "INTEGERS".
BUT TODAY,
THERE IS SOMETHING THAT I'VE LEARNT AFTER LISTENING TO WHAT SENPAI HAS SAID

COPRIMALITY.
SQUARE NUMBERS
PRODUCT FORM.
DECOMPOSITION INTO PRIME FACTORS.
PARITY.
DESPITE LOOKING EASY,
THEY ARE NOT TO BE UNDERESTIMATED.
ARE GIVING OUT SQUEAKING SOUNDS.
—IT FEELS JUST AS IF INTEGERS
BUT THAT'S NOT TRUE.
INTEGERS WERE GIVING AN ILLUSION OF BEING EASIER.
IN COMPARISON WITH QUADRATIC EQUATIONS OR THE CALCULUS,
IS BECAUSE SENPAI PATIENTLY EXPLAINED IT TO ME.
THE REASON I UNDERSTOOD THAT TOO,


WHENEVER I LISTEN TO SENPAI'S TALKING,
I LEARN "SOMETHING" THAT'S DIFFERENT FROM LESSONS OR BOOKS.
DESPITE THE TOPIC BEING SOMETHING THAT I'M SUPPOSED TO KNOW VERY WELL,
IT'S SOMETHING THAT MAKES ME SURPRISED .
SO FAR,
I'VE SETTLED ALL SORTS OF THINGS CLAIMING THAT "I KNEW".
...BUT,
IT MIGHT HAVE REALLY BEEN THAT I "THOUGHT I KNEW"...

BECAUSE SENPAI IS HERE, I DIDN'T GET DISCOURAGED.
BUT—
I KNEW IT VERY WELL.
THE FACT THAT I DON'T REALLY UNDERSTAND INTEGERS...
BUT, I FEEL THAT ONE DAY I WILL BE ABLE TO GET OUT.
RIGHT NOW, I'M LOST IN THE MIDDLE OF A FOREST.
I'M NOT REALLY TALKING ABOUT MATHS..
...UM,
THIS IS ABOUT MATHS, BUT,

Shudder
IT'S THE END OF THE SCHOOL DAY.
U- UM, SENPAI-
CLATTER
THANK YOU VERY MUCH,
FOR TODAY'S BEAUTIFUL JOURNEY!

LET'S GO HOME MIRUKA-TAN.
MUSIC ROOM
ALL RIGHT.

Checking parity.

The special characteristic of integers is that they are "discrete". Discrete means that they take "values present at intervals" ..., -3, -2, -1, 0, 1, 2, 3, ...

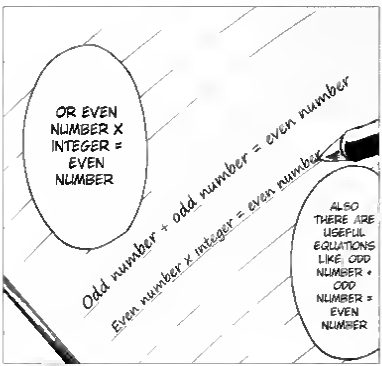
When thinking about a problem about integers, it's very important to think about "even" or "odd". Being even means being divisible by 2 without a remainder, in other words ..., -4, -2, 0, 2, 4, ...

And, being odd means not being divisible by 2 without a remainder, in other words ..., -5, -3, -1, 1, 3, 5, ...

Checking whether an integer is even or odd is called "checking parity".

Adding an odd number and an odd number will certainly give an even number. And multiplying an even number by an integer will certainly give an even number. Moreover, when we have an equality of integers on both sides, if the left-hand side is an even number, then the right-hand side will also be an even number, and when the left-hand side is an odd number, the right-hand side will also be an odd number.

There are many occasions when something as obvious as "checking parity" can become the impetus for solving a problem.


OR EVEN NUMBER X INTEGER = EVEN NUMBER
Odd number + odd number = even number
Even number x integer = even number
ALSO THERE ARE USEFUL EQUATIONS LIKE, ODD NUMBER + ODD NUMBER = EVEN NUMBER

数学ガール

Mathematical Girls Fermat's Last Theorem

フェルマーの最終定理